

CLAIMS

What is claimed is:

1. A single-chip structure of silicon germanium photodetectors and high-speed transistors which comprise of:
 - 5 a substrate;
 - a phototransistor, which is formed on a side of the substrate;
 - a high-speed bipolar transistor which is relocated in the opposite side of the phototransistor on substrate; and
 - a separated insulation-layer, using this layer to separate the phototransistor and the high-speed bipolar transistor, consisting of the above components, a single-chip structure of the phototransistor and the high-speed bipolar transistor can be completely implemented on a same substrate.
- 10 2. A single-chip structure of SiGe photodetectors and high-speed transistors, which comprises of claim 1 wherein the substrate can be making from a silicon wafer or a silicon-on-insulator wafer.
- 15 3. A single-chip structure of SiGe photodetectors and high-speed transistors, which comprises of claim 1 wherein the phototransistor and high-speed bipolar transistor structure includes:
 - 20 a composite collector layer consists of a collector layer and a photo-absorbing layer, wherein the photo absorbing layer is formed on the collector layer;
 - a base layer, located on the composite collector layer;
 - 25 an emitter layer, formed on the base layer.

4. A single-chip structure of SiGe photodetectors and high-speed transistors, which comprise of claim 1 wherein the separated insulation layer is either made by filling the deep trench with the insulation material or using the reverse p-n junction, it can isolate the photo-detecting zone and the high-speed transistor zone distinctly.
5. The structure of the phototransistor and high-speed bipolar transistor, which comprise of claim 3 wherein the collector layer of the composite collector layer, can choose silicon to make it.
- 10 6. The structure of the phototransistor and high-speed bipolar transistor, which comprise of claim 3 wherein the photo-absorbing layer can adopt either Si/Si_{1-x}Ge_x multiple quantum well or superlattice, the X range of Ge component in Si_{1-x}Ge_x is defined as $0 < X \leq 1$, not only owns the ability to absorb the light spectrum with an infrared wavelength, also improves the light absorption efficiency indeed.
- 15 7. The structure of the phototransistor and high-speed bipolar transistor, which comprise of claim 3 wherein the base layer can made of either silicon or silicon germanium, then its thickness is determined by the required speed performance of the high-speed bipolar transistor.
- 20 8. The structure of the phototransistor and high-speed bipolar transistor, which comprise of claim 3 wherein the emitter layer can be made of silicon, poly silicon or silicon germanium, its thickness can be as smaller as 10 nm and goes up to unbounded.
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9. The structure of the phototransistor and high-speed bipolar transistor, which comprise of claim 3 wherein the emitter and collector layers shall be n-type doping, if the base layer is the p-type doping, the emitter and collector layers shall be p-type doping with n-type doping to the base layer, the photo-absorbing layer of the phototransistor can be made of an intrinsic (no doping), n-type, or p-type material.
10. The structure of the phototransistor and high-speed bipolar transistor, which comprise of claim 3 wherein the emitter layer can be designed to partially or totally cover the base layer.
11. A single-chip structure of SiGe photodetectors and high-speed transistors, which comprise of:
- a substrate;
 - a photodiode, which is formed on a side of the substrate;
 - a high-speed bipolar transistor which is relocated in the opposite side of the photodiode on substrate; and
 - a separated insulation layer, using this layer to separate the photodiode and the high-speed bipolar transistor, consisting of the above components, the photodiode and the high-speed bipolar transistor can be completely implemented by using a single-chip structure.
12. A single-chip structure of SiGe photodetectors and high-speed transistors, which comprises of claim 11 wherein the substrate can be choosing from silicon wafer or silicon-on-insulator wafer.
13. A single-chip structure of SiGe photodetectors and high-speed

transistors, which comprises of claim 11 wherein the photodiode and high-speed bipolar transistor structure includes:

a composite collector layer consists of a collector layer and a photo-absorbing layer, wherein the photo-absorbing layer is formed on the collector layer;

a base layer, formed on the composite collector layer;

an emitter layer, formed on the base layer of the high-speed bipolar transistor, but the photodiode has no emitter layer.

14.A single-chip structure of SiGe photodetectors and high-speed transistors, which comprises of claim 11 wherein the separated insulation layer is either made by filling the deep trench with the insulation material or using the reverse p-n junction, it can isolate the photo-detecting zone and the high-speed transistor zone distinctly.

15.The structure of the photodiode and high-speed bipolar transistor, which comprises of claim 13 wherein the collector layer of the composite collector layer, can choose silicon to make it.

16.The structure of the photodiode and high-speed bipolar transistor, which comprises of claim 13 wherein the photo-absorbing layer can adopt either $\text{Si}/\text{Si}_{1-x}\text{Ge}_x$ multiple quantum well or superlattice, the X range of Ge component of $\text{Si}_{1-x}\text{Ge}_x$ is defined as $0 < X \leq 1$, not only owns the ability to absorb the light spectrum with an infrared wavelength, also improves the light absorption efficiency indeed.

17.The structure of the photodiode and high-speed bipolar transistor,

which comprises of claim 13 wherein the base layer can made of either silicon or silicon-germanium, then its thickness is determined by the required speed performance of the high-speed bipolar transistor.

- 5 18. The structure of the photodiode and high-speed bipolar transistor, which comprises of claim 13 wherein the emitter layer of the high-speed bipolar transistor can be made of silicon, poly silicon or silicon-germanium, its thickness can be as smaller as 10 nm and goes up to unbounded.
- 10 19. The structure of the photodiode and high-speed bipolar transistor, which comprises of claim 13 wherein the emitter and collector layers shall be n-type doping, if the base layer is the p-type doping, oppositely the emitter and collector layers shall be p-type doping with n-type doping to the base layer, the
- 15 photo-absorbing layer of the phototransistor can be made of an intrinsic (no doping), n-type, or p-type material.